sanwa
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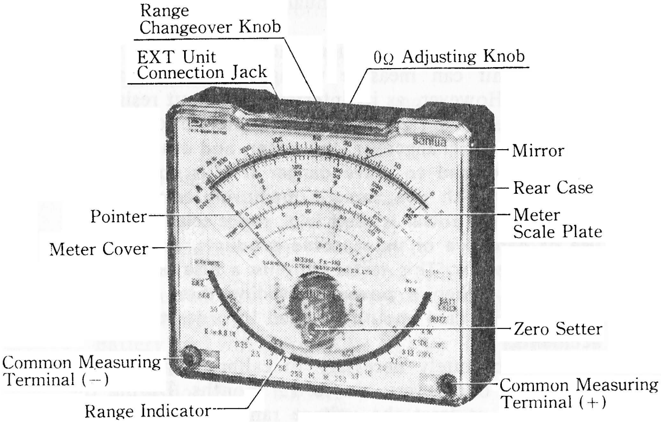
FX-110
MULTITESTER

INSTRUCTION MANUAL

NAME OF PARTS



Thank you very much for purchasing SANWA's Multi-Tester FX-110. This high-performance product features a unique rotary ring switch, a large meter, and multiple functions. With the attachment of optional adapter units FU-1H and FU-2R, it can also measure C (F), hFE, low power and linear resistances. We are confident that the user will be satisfied with the performance of this product.

Before using the product, the user is advised to read through this instructions manual so he can always make correct measurements.

The tester is a convenient measuring device which in one unit can measure voltages, currents and resistances. However, as its interterminal input resistance varies largely from very high several MΩ to low several Ω with range changeover, **the tester, and even its user, may be exposed to grave danger if it is not used or maintained with due care. A measuring error when a large-capacity power is used (e.g., range selection error, use of defective or uninspected products, etc.) can be very dangerous. This tester contains a fuse rated 250V and 0.5A. When a power exceeding these ratings is used, special care should be used in order to prevent accidents.**

It is absolutely necessary to calibrate and inspect the tester once every six to 12 months. During the inspection, at least the voltage range indication must be checked and the withstand voltage tested. To have the tester calibrated and inspected, one suggested method is to send it to a nearby electric equipment testing lab.

1. SPECIFICATIONS

Measuring Ranges

○ Direct-current voltage (DCV): 0.1–0.25–2.5–10–50–250–1k
Internal resistance: 25kΩ/V (1kΩ for 0.1V range)

○ Direct current (DCmA): 0.1–5–50–500
Voltage drop: 500mV (100mV for 0.1mA range)

○ Alternating-current voltage (ACV): 2.5–10–50–250–1k
Internal resistance: 10kΩ/V

○ Resistance (Ω):

	x 1	x 10	x 100	x 1k
	0 to 5kΩ	0 to 50kΩ	0 to 500kΩ	0 to 5MΩ
Central graduations:	50Ω	500Ω	5kΩ	50kΩ

Inside battery: UM-3 (1.5V x 2)

* [○ Temperature (°C)]: 120°C 200°C
−40 to 120°C 0 to 200°C

○ Load current (LI): 0.06mA–0.6mA–6mA–60mA

○ Load voltage (LV): 0 to 3V

○ Battery load voltage (BATT CHECK): 0.9 to 1.5V
Load resistance: 10Ω

○ Conduction check buzzer:
Terminal voltage: Within about 3V
Current consumption: About 1.6mA

** [○ High voltage]: 0 to 30kV (DC)

○ EXT: The range for connecting attached units (0.1V, 40μA)

* To measure temperatures, a temperature probe (option) is necessary.

** To measure high voltages, a high-voltage probe (option) is necessary.

Accuracy

DCV, DCmA, EXT: Within ±3% of the max. graduation

ACV (Above 10V): Within ±4% of the max. graduation

ACV (2.5V only): Within ±6% of the max. graduation

Ω, °C: Within ±3% of the scale length.

Dimensions and Weight

103mm x 116mm x 40mm

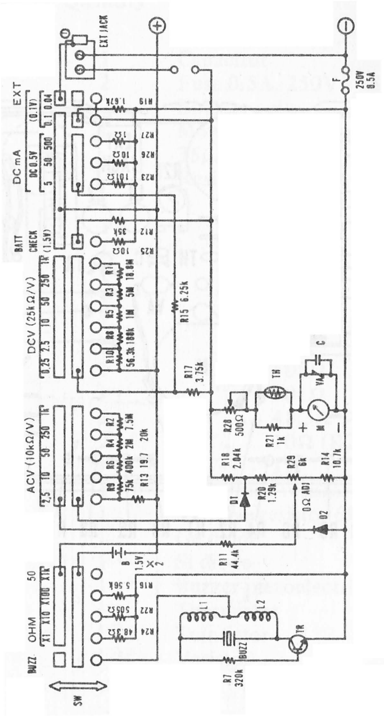
About 300g

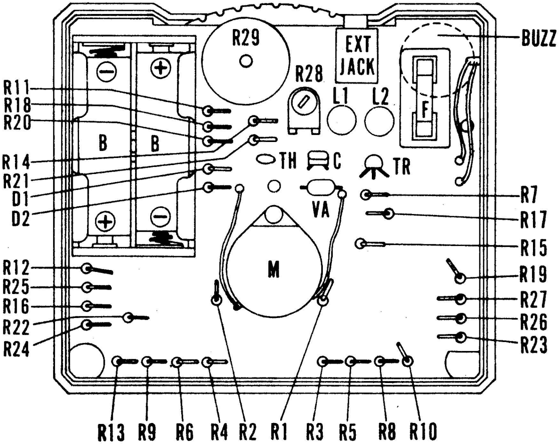
Accessories

One pair of test leads (TL-95)

One spare fuse 250V–0.5A (contained in the tester)

One copy of instructions manual

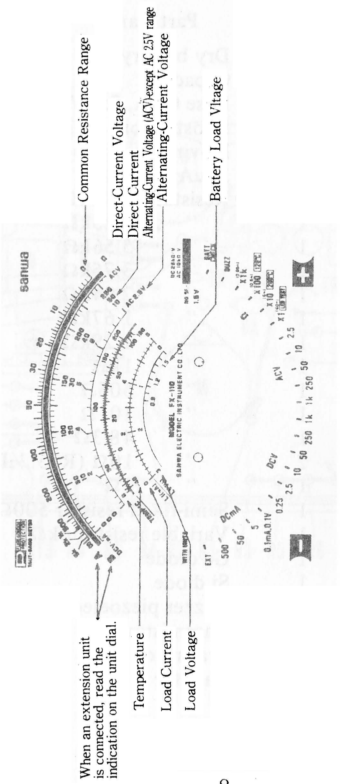




4. LIST OF IMPORTANT PARTS

Mark	Quantity	Part Name	Remarks
B	2	Dry battery	
C	1	Capacitor	
F	2	Fuse 0.5A, 250V	Spare: 1
L1,L2	2	Booster coils	
M	1	Moving coil-type meter 35μA ©2.1kΩ	
R1~R14	14	Resistors 18.8MΩ to 10.7kΩ	
R15	1	″ 6.25kΩ	
R16	1	″ 5.56kΩ	
R17	1	″ 3.75kΩ	
R18	1	″ 2.04kΩ	
R19	1	″ 1.67kΩ	
R20	1	″ 1.29kΩ	
R21	1	″ 1kΩ	
R22	1	″ 505Ω	
R23	1	″ 101Ω	
R24	1	″ 48.3Ω	
R25,R26	2	″ 10Ω (R25..½P)	
R27	1	″ 1Ω	
R28	1	Semi-fixed resistor 500Ω	
R29	1	Variable resistor 6kΩ	
D1	1	Ge diode	
D2	1	Si diode	
BUZZ	1	Buzzer piezoelectric 20mmϕ	
TH	1	Thermistor	
TR	1	Transistor	
VA	1	Varistor	

5. HOW TO READ SCALES



When an extension unit is connected, read the indication on the unit dial.

The scales to be read are indicated by different-color lines above the range indications.

6. MEASURING METHODS

6.1 PREPARATIONS

Zero Setting of Meter

By turning the meter zero setter, align the pointer with the zero graduation on the extreme left of the scale plate. Although this need not be done so frequently, it should be noted that the meter indication contains just as large an error as the error at the zero position.

Range Selection

Select the needed measuring range by turning the range changeover knob.

The range in use is indicated by the range indicator.

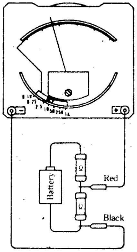
Connection of Test Leads to Measuring Terminals

Insert completely the black test lead into the minus common measuring terminal and the red test lead into the plus measuring terminal.

Conduction Test of Inside Fuse

This is an important test item because if the inside fuse should have burned out, not only is the measurement impossible but the user also may be misled about the fuse conductivity and get electric shock. A simple testing method is to switch the range to Ω and short the two test leads. If the pointer swings, the fuse is normal. If the fuse has burned out, replace it with a new one rated 250V and 0.5A. After this test, do not forget to return the range to one to be used.

6.2 MEASUREMENT OF DIRECT-CURRENT VOLTAGE (DCV)



1. Switch the range.
2. Touch the measuring points (the red lead: plus side; black lead: minus side).
3. Read the indication.

(a) Measuring Method

Since direct current is involved, take care about the polarities. Then connect the test leads in parallel to the power source and make the measurement.

(b) How to Read Graduations

In all ranges, read the indication on the DCV-mA scale.

- In 0.1V range: The graduations 0 to 10 are multiplied by 0.01.
- In 0.25V range: The graduations 0 to 250 are multiplied by 0.001.
- In 2.5V range: The graduations 0 to 250 are multiplied by 0.01.
- In 10V range: The graduations 0 to 10 are read directly.
- In 50V range: The graduations 0 to 50 are read directly.
- In 250V range: The graduations 0 to 250 are read directly.
- In 1kV range: The graduations 0 to 10 are multiplied by 100 (V).

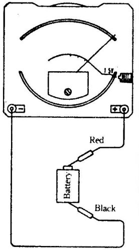
(c) Influence of Internal Resistance (Ω/V) on Voltage Measurement

When the tester is connected to the measuring points to measure the voltage, the voltage to be measured flows across the tester. This results in changing the operating condition of the circuit being measured, causing the measured value to differ from the actual voltage during normal operation.

To minimize this difference, it is necessary for the tester to have an internal resistance substantially larger (more than 10 times) than the resistance between the measuring points.

The internal resistance in the ranges above DC 0.25V can be calculated by: 25kΩ x V Value of the Range

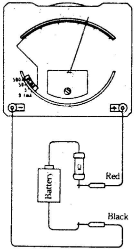
6.3 MEASUREMENT OF BATTERY LOAD VOLTAGE (DC 1.5V)



1. Switch the range.
2. Touch the measuring points.
3. Read the indication.

To measure a battery, align the range indicator to BATT CHECK position. The internal resistance for this range (the battery load resistance: RL) is 10Ω. So in the case of 1.5V battery, the voltage when 150mA current is taken out can be measured, hence whether a battery is good or bad can be determined. The graduations 0.9 to 1.5V for BATT CHECK can be read directly.

6.4 MEASUREMENT OF DIRECT CURRENT (DCmA)



1. Switch the range.
2. Touch the measuring points. (Red lead: plus side; black lead: minus side)
3. Read the indication.

(a) Measuring Method

As direct current is involved, take care about the polarities of the power. Then cut off the circuit of the measuring points and connect the leads to both ends in series to make the measurement.

(b) How to Read Graduations

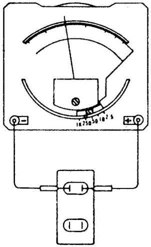
In all ranges, read the indication on the DCV-mA scale.

- In 0.1mA range: The graduations 0 to 10 are multiplied by 0.01.
- In 5mA range: The graduations 0 to 50 are multiplied by 0.1.
- In 50mA range: The graduations 0 to 50 are read directly.
- In 500mA range: The graduations 0 to 50 are multiplied by 10.

(c) Internal Resistance and its Influence

In measuring currents, the internl resistance of the current range is added in series to the circuit, so much decreasing the current. In the case of low-resistance circuits, therefore, be careful about its influence.

6.5 ALTERNATING-CURRENT VOLTAGE (ACV)



1. Switch the range.
2. Touch the measuring points.
3. Read the indication.

(a) Measuring Method

As this is alternating current, there is no need to worry about the polarities of the power. Connect the leads in parallel and make the measurement.

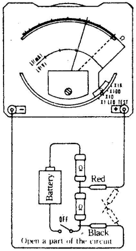
(b) How to Read Graduations

- In AC 2.5V range: The graduations 0 to 250 on AC 2.5V scale (red) are multiplied by 0.01.
- In AC 10V range: The graduations 0 to 10 on ACV scale are read directly.
- In AC 50V range: The graduations 0 to 50 on ACV scale are read directly.
- In AC 250V range: The graduations 0 to 250 on ACV scale are read directly.
- In AC 1kV range: The graduations 0 to 10 on ACV scale are multiplied by 100 (V).

(c) Frequency and Influence of Waveform

In AC 10V and 2.5V ranges, measurement can be made in a broad range from 30Hz to 1MHz. Under 30Hz, reading becomes difficult because of pointer vibration, and above 1MHz, the measurement contains an error larger than 10% than in the case of 50Hz/60Hz. Also it should be noted that since the graduations are calibrated by the root mean square value of the sinewave alternating current, errors can occur when alternating-current voltages of other waveforms having different form factors are measured.

6.6 MEASUREMENT OF RESISTANCE (Ω)



1. Switch the range.
2. Short the plus and minus leads (broken lines).
3. While maintaining the above state, make 0Ω adjustment.
4. Touch the measuring points.
5. Read the indication.

(a) 0Ω Adjustment

If the range switch is turned to Ω range and the plus and minus leads are shorted, the pointer swings. While maintaining this state, turn the 0Ω adjuster to bring the pointer to above 0Ω line at the extreme right of the scale. When the inside battery begins to run out, the pointer refuses to swing to 0Ω. In this case, replace the battery with a new one as soon as possible.

(b) How to Read Graduations

In all ranges, read the indication on the Ω scale.

- In x 1 range: The graduations are read directly.
- In x 10 range: They are multiplied by 10.
- In x 100 range: They are multiplied by 100.
- In x 1k range: The graduations are read directly (for kΩ unit).

(c) Tester Polarities during Resistance Measurement

In Ω range, the plus measuring terminal is connected to the minus pole of the inside battery, as shown in the circuit diagram. Therefore, in Ω range only, the polarities of the measuring terminals are reversed. Bear this in mind when measuring semiconductors such as diodes and transistors.

(d) Replacement of Inside Battery

Loosen the locking screw on the rear side of the case and take off the case. Replace the battery with new battery (Unit-3 dry battery x 2).

(e) Test for LED Lamp

Connection of the LED lamp to the (+) and (−) terminals in x 1 range enables the user to test luminescence of the lamp within the max. current 60mA.

6.7 HOW TO KNOW LOAD CURRENT (LI) AND LOAD VOLTAGE (LV)

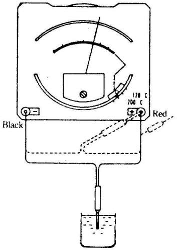
When a resistance value is measured in Ω range, it is convenient if the user can know also the measuring current and voltage at that time, because then he can check the characteristics of nonlinear devices (diodes and other semiconductors). Another consideration is that the resistance value may change depending on the measuring current when thermistors and very fine wires are measured. The measuring current and voltage can be obtained as load current LI and load voltage LV, respectively. Suppose that a resistance value was measured in x 1 range and found out to be 100Ω. At this time, LI can be found at 20mA and LV at 2V simultaneously.

How to Read Graduations

- For LI, the graduations 0 to 6 on the LI scale are:
  - In x 1 range: To be multiplied by 10.
  - In x 10 range: To be read directly.
  - In x 100 range: To be multiplied by 0.1.
  - In x 1k range: To be multiplied by 0.01.
- For LV, the graduations 3 to 0 on the LV scale are read directly in all ranges.

(Note) These readings are when the voltage of the inside battery is 3V. Note that errors of up to 20% can occur with the change in the voltage level.

6.8 MEASUREMENT OF TEMPERATURE (°C)



1. Switch the range.
2. Short the plus and minus. (Short the probe tip metal with the plus terminal.)
3. While maintaining the above state, make 0Ω adjustment.
4. Insert the red lead into the (+) terminal, then touch the measuring point with the probe tip metal.
5. Read the indication.

(a) Measuring Method

Temperature is measured by measuring the resistance value of the thermistor temperature probe in resistance range. Therefore, the measuring procedure is the same as that for resistance. The measuring portion of the temperature probe is grounded to the black test lead.

So if this measuring portion is put in contact with the plus measuring terminal and the black lead pin is inserted into the minus measuring terminal, the two terminals short causing the pointer to swing. While maintaining this condition, turn the 0Ω adjuster to bring the pointer to the extreme right of TEMP scale (full scale point). After this full scale adjustment, insert the red lead pin into the plus measuring terminal and measure the temperature with the measuring portion.

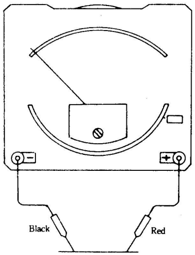
(b) How to Read Graduations

The following graduations on the TEMP scale can be read directly:

- In 120°C range: –40 to 120 on the lower side.
- In 200°C range: 0 to 200 on the upper side.

6.9 BUZZER RANGE (BUZZ)

This range is meant to test conductivity with a buzzer.



1. Switch the range.
2. Touch the testing points.
3. See if the buzzer sounds. (If there is conduction, the buzzer sounds.)

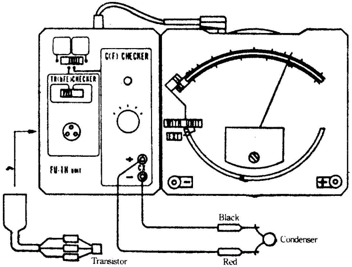
If the resistance value is between 0Ω to about 1kΩ, the buzzer sounds (but the sound becomes gradually smaller as the resistance value increases). If the resistance value is higher than 1kΩ, the sound becomes hard to recognize or inaudible. (The voltage applied is less than 3V.)

6.10 EXTERNAL RANGE (EXT)

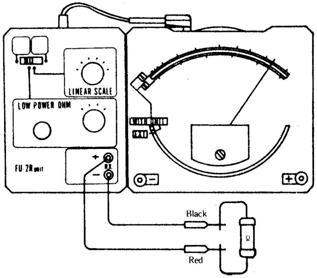
With the combined use of optional adapter units (FU-1H and FU-2R), this tester, in addition to its own measuring functions, can also measure capacitor capacity, transistor h_{FE}, low power resistance, and linear resistance.

(a) Measurement of Transistor h_{FE} and Capacitor Capacity (Using FU-1H)

- Transistor h_{FE}: There are two ranges of h_{FE} = 250, 1000.
- Capacitor capacity: There are five ranges of 1000pF, 0.01μF, 0.1μF, 1μF and 10μF.
- Measuring voltage: Less than 8V



(b) Low Power Resistance and Linear Resistance



(Using FU-2R)

- Low power ohmmeter:
  This ohmmeter measures in in-circuit condition by reducing the applied voltage to a low level. There are four ranges of x1, x 10, x 100 and x 1k.
  Voltage applied: Less than 100mV
- Linear ohmmeter:
  This ohmmeter can measure high resistances of max. 25MΩ on a linear scale. There are six ranges of 250Ω, 2.5kΩ, 25kΩ, 250kΩ, 2.5MΩ and 25MΩ.
  Voltage applied: Less than 1.5V (at the time of max. graduation)

* For the measuring methods in detail, see the handling instructions accompanying the adapter units.

7. CAUTIONS

(1) Place the tester on places as horizontal as possible and try to look at the pointer from right above it.

(2) The tester is very sensitive. Take good care **not to let it receive vibrations and impacts.**

(3) Make sure that the right range is used.

Each time the tester is used, make sure without fail that the right range is used (by checking the position of the range indicator). Should voltage be measured in Ω or DCmA range, for instance, not only will inside parts burn out to put the tester out of use, but accidents also can happen with **very grave danger to the user.**

(4) Do not expose the tester to direct sunrays and **do not leave it in places of high temperature or humidity** as these can damage the meter and deteriorate diodes and other parts.

(5) This meter uses an internal magnet-type meter, so it does not make indication errors if it is used on steel plates, etc. Compared with other products, this meter is structurally less vulnerable to outside magnetism, yet avoid taking it into strong magnetic field.

(6) The acrylic material of the meter cover has been specially treated to prevent electrostatic buildup. Therefore, do not rub it hard or wipe it with any volatile solvent, but just brush it if becomes dusty.

(7) Do not leave exhausted battery inside the tester because electrolyte may leak out erroding inside components.

(8) The user can expect higher accuracies with less possibility of errors if he tries to measure voltages and currents with graduations as near the extreme right of the meter as possible and to measure resistances with graduations as near the center of the meter as possible.

(9) A measuring error when a large-capacity power is used can be very dangerous. To prevent accidents, take care not to use defective or uninspected parts or to use a wrong range.

(10) When measuring unfamiliar voltages or currents, check first their approximate levels in the largest ranges, then switch to the optimum ranges to measure them correctly.

(11) Do not hold the tester in hand when making measurements. This is because the user may be in a serious accident should the tester be an uninspected or defective product. For the sake of safety, the user is requested never to touch the tester during measurement.

(12) Use the test leads specially designed for this tester (TL-95 test leads).

(13) **Open and close the switches of the tester and the equipment after removing the test leads from the tester. Also, when measuring circuits containing automatic switches, take good care as they can generate pulse and induced voltages.**

8. REPLACEMENT PARTS

With 0.5A fuse and meter overload protecting device, this unit protects its meter against any excessive input of weak power (less than AC 600V) as a result of range misselection. Nevertheless, resistors and diodes will be damaged by excessive power input, requiring replacement and repair. The following are simple methods for discovering whether these parts are damaged or not.

1. Damage of Resistor

Measure the resistance value. The resistor used in this tester is nonflammable and it only punctures partially when excessive power is inputted. This makes it hard to distinguish visually whether it is damaged or not.

2. Damage of Rectifier Diodes (D1, D2)

The indication in AC range becomes negative (deterioration of diodes), or the pointer ceases to swing at all (damage of diodes).

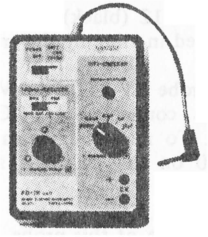
3. Melting of Fuse

Switch to Ω range and short the test leads. If the pointer refuses to swing, there is a good possibility that the fuse has melted.

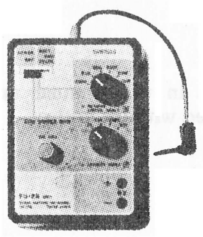
OPTIONAL UNITS AND ACCESSORIES

○ **Adapter units:**

FU-1H: This is for measuring h_{FE} and capacitor capacity.



FU-2R: This is for measuring low power resistance and linear resistance.



- **Carrying case:**
  The FX-110 tester can be conveniently protected and carried in this case. (There are cases for both tester only and tester and adapter units put together.)
- **Clip adapter:**
  This adapter makes measurement easier if it is connected to TL-12 (black) and TL-12R (red) test leads and is used in clipping the ground wire, etc. to be measured.
- **High-voltage probe HV-7 (DC 30kV):**
  This probe is connected to DC 1kV range for measurement. To read the indication, the graduations 0 to 50 on the DCV-mA scale can be read directly.
- **Temperature probe FTH:**
  With combined use of this probe, temperatures can also be measured. For the measuring method, see "Measurement of Temperature (°C) ..(Page 16 and 17).

Specifications in this manual may be changed or discontinued without notice